Two-photon interference in an atom-quantum dot hybrid system

H. Vural[1], S. L. Portalupi[1], J. Maisch[1], S. Kern[1], J. H. Weber[1], M. Jetter[1], J. Wrachtrup[3,4], R. Löw[2], I. Gerhardt[3,4] and P. Michler[1]

[1] Institut für Halbleiteroptik und Funktionelle Grenzflächen, Center for Integrated Quantum Science and Technology (IQ^{ST})
and SCoPE, University of Stuttgart, Allmandring 3, D-70569 Stuttgart, Germany
[2] 5. Physikalisches Institut and Center for Integrated Quantum Science and Technology, University of Stuttgart, Pfaffenwaldring 57, D-70569 Stuttgart, Germany
[3] 3. Physikalisches Institut and Center for Integrated Quantum Science and Technology, University of Stuttgart, Pfaffenwaldring 57, D-70569 Stuttgart, Germany
[4] Max Planck Institute for Solid State Research, Heisenbergstrae 1, D-70569 Stuttgart, Germany

Future quantum networks require flying qubits and stationary nodes. Hybridization [1-3] of single semiconductor quantum dots (QD), which provide ultra-bright on-demand single-photon emission, and alkali vapors with their possibility of broadband photon storage capabilities [4] constitute a platform for such networks. However, spectral diffusion, inherent in most solid-state emitters, is a limiting factor for the fidelity of networking. Here, we investigate the role of spectral diffusion of QDs on the hybridization with a cesium (Cs)-vapor. Fine-tuning the QD emission between the Cs-D_1 transitions enables a temperature dependent delay on the single quanta. The strong dependence of this effect on the photon's frequency is used to map spectral information into temporal domain, thus revealing insight into the semiconductor emitter spectral diffusion dynamics.
Moreover the quantum optical properties of the QD photons after the interaction with the vapor are presented. The single-photon purity remains unchanged and the coherence of photon-vapor interaction is proved to be conserved [3] by means of two-photon interference measurements. Theoretically achievable performances for this scheme are presented.

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